1.2. Regex examples

A simple example for a regular expression is a (literal) string. For example, the *Hello World* regex will match the "Hello World" string. `.` (dot) is another example for a regular expression. A dot matches any single character; it would match, for example, "a" or "z" or "1".

The following tables lists several example regular expressions and describes which pattern they would match.

Table 1. Regex example

Regex	Matches
this is text	Matches exactly "this is text"
this\s+is\s+text	Matches the word "this" followed by one or more whitespace characters followed by the word "is" followed by one or more whitespace characters followed by the word "text".
^\d+(\.\d+)?	^ defines that the patter must start at beginning of a new line. \d+ matches one or several digits. The ? makes the statement in brackets optional. \. matches ".", parentheses are used for grouping. Matches for example "5", "1.5" and "2.21".

1.3. Support for regular expressions in programming languages

Regular expressions are supported by most programming languages, e.g., Java, Perl, Groovy, etc. Unfortunately each language supports regular expressions slightly different.

2. Prerequisites

The following tutorial assumes that you have basic knowledge of the Java programming language.

Some of the following examples use JUnit to validate the result. You should be able to adjust them in case if you do not want to use JUnit. To learn about JUnit please see JUnit Tutorial.

3. Rules of writing regular expressions

The following description is an overview of available meta characters which can be used in regular expressions. This chapter is supposed to be a references for the different regex elements.

3.1. Common matching symbols

Table 2.

Regular Expression	Description
`.`	Matches any character
`^regex`	Finds regex that must match at the beginning of the line.
`regex$`	Finds regex that must match at the end of the line.
`[abc]`	Set definition, can match the letter a or b or c.
`[abc][vz]`	Set definition, can match a or b or c followed by either v or z.
`[^abc]`	When a caret appears as the first character inside square brackets, it negates the pattern. This ccontent/an match any character except a or b or c.
`[a-d1-7]`	Ranges: matches a letter between a and d and figures from 1 to 7, but not d1.

Regular Expression	Description
X|Z	Finds X or Z.
XZ	Finds X directly followed by Z.
$	Checks if a line end follows.

3.2. Meta characters

The following meta characters have a pre-defined meaning and make certain common patterns easier to use, e.g., `\d` instead of `[0..9]`.

Table 3.

Regular Expression	Description
`\d`	Any digit, short for `[0-9]`
`\D`	A non-digit, short for `[^0-9]`
`\s`	A whitespace character, short for `[ \t\n\x0b\r\f]`
`\S`	A non-whitespace character, short for `[^\s]`
`\w`	A word character, short for `[a-zA-Z_0-9]`
`\W`	A non-word character `[^\w]`
`\S+`	Several non-whitespace characters
`\b`	Matches a word boundary where a word character is `[a-zA-Z0-9_]`.

Tip

These meta characters have the same first letter as their representation, e.g., digit, space, word, and boundary. Uppercase symbols define the opposite.

3.3. Quantifier

A quantifier defines how often an element can occur. The symbols ?, *, + and {} define the quantity of the regular expressions

Table 4.

Regular Expression	Description	Examples
`*`	Occurs zero or more times, is short for `{0,}`	`X*` finds no or several letter X, `.*` finds any character sequence
`+`	Occurs one or more times, is short for `{1,}`	`X+` - Finds one or several letter X
`?`	Occurs no or one times, `?` is short for `{0,1}`.	`X?` finds no or exactly one letter X
`{X}`	Occurs X number of times, `{}` describes the order of the preceding liberal	`\d{3}` searches for three digits, `.{10}` for any character sequence of length 10.
`{X,Y}`	Occurs between X and Y times,	`\d{1,4}` means `\d` must occur at least once and at a

Regular Expression	Description	Examples
		maximum of four.
`*?`	`?` after a quantifier makes it a *reluctant quantifier*. It tries to find the smallest match. This makes the regular expression stop at the first match.	

3.4. Grouping and Backreference

You can group parts of your regular expression. In your pattern you group elements with round brackets, e.g., `()`. This allows you to assign a repetition operator to a complete group.

In addition these groups also create a backreference to the part of the regular expression. This captures the group. A backreference stores the part of the `String` which matched the group. This allows you to use this part in the replacement.

Via the `$` you can refer to a group. `$1` is the first group, `$2` the second, etc.

Let's, for example, assume you want to replace all whitespace between a letter followed by a point or a comma. This would involve that the point or the comma is part of the pattern. Still it should be included in the result.

```
// Removes whitespace between a word character and . or ,
String pattern = "(\\w)(\\s+)([\\.,])";
System.out.println(EXAMPLE_TEST.replaceAll(pattern, "$1$3"));
```

This example extracts the text between a title tag.

```
// Extract the text between the two title elements
pattern = "(?i)(<title.*?>)(.+?)(</title>)";
String updated = EXAMPLE_TEST.replaceAll(pattern, "$2");
```

3.5. Negative Lookahead

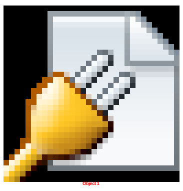
Negative Lookahead provides the possibility to exclude a pattern. With this you can say that a string should not be followed by another string.

Negative Lookaheads are defined via `(?!pattern)`. For example, the following will match "a" if "a" is not followed by "b".

```
a(?!b)
```

3.6. Backslashes in Java

The backslash `\` is an escape character in Java Strings. That means backslash has a predefined meaning in Java. You have to use double backslash `\\` to define a single backslash. If you want to define `\w`, then you must be using `\\w` in your regex. If you want to use backslash as a literal, you have to type `\\\\` as `\` is also an escape character in regular expressions.



4. Using Regular Expressions with String.matches()

4.1. Overview

`Strings` in Java have built-in support for regular expressions. `Strings` have four built-in methods for regular expressions, i.e., the `matches()`, `split())`, `replaceFirst()` and `replaceAll()` methods. The `replace()` method does NOT support regular expressions.

These methods are not optimized for performance. We will later use classes which are optimized for performance.

Table 5.

Method	Description
`s.matches("regex")`	Evaluates if `"regex"` matches `s`. Returns only `true` if the WHOLE string can be matched.
`s.split("regex")`	Creates an array with substrings of `s` divided at occurrence of `"regex"`. `"regex"` is not included in the result.
`s.replaceFirst("regex"), "replacement"`	Replaces first occurance of `"regex"` with `"replacement`.
`s.replaceAll("regex"), "replacement"`	Replaces all occurances of `"regex"` with `"replacement`.

Create for the following example the Java project `de.vogella.regex.test`.

```
package de.vogella.regex.test;

public class RegexTestStrings {
  public static final String EXAMPLE_TEST = "This is my small example "
      + "string which I'm going to " + "use for pattern matching.";

  public static void main(String[] args) {
    System.out.println(EXAMPLE_TEST.matches("\\w.*"));
    String[] splitString = (EXAMPLE_TEST.split("\\s+"));
    System.out.println(splitString.length);// should be 14
    for (String string : splitString) {
      System.out.println(string);
    }
    // replace all whitespace with tabs
    System.out.println(EXAMPLE_TEST.replaceAll("\\s+", "\t"));
  }
}
```

4.2. Examples

The following class gives several examples for the usage of regular expressions with strings. See the comment for the purpose.

If you want to test these examples, create for the Java project `de.vogella.regex.string`.

```
package de.vogella.regex.string;

public class StringMatcher {
  // returns true if the string matches exactly "true"
  public boolean isTrue(String s){
    return s.matches("true");
  }
  // returns true if the string matches exactly "true" or "True"
  public boolean isTrueVersion2(String s){
    return s.matches("[tT]rue");
  }

  // returns true if the string matches exactly "true" or "True"
  // or "yes" or "Yes"
  public boolean isTrueOrYes(String s){
    return s.matches("[tT]rue|[yY]es");
  }

  // returns true if the string contains exactly "true"
  public boolean containsTrue(String s){
    return s.matches(".*true.*");
  }


  // returns true if the string contains of three letters
  public boolean isThreeLetters(String s){
    return s.matches("[a-zA-Z]{3}");
    // simpler from for
//    return s.matches("[a-Z][a-Z][a-Z]");
  }



  // returns true if the string does not have a number at the beginning
  public boolean isNoNumberAtBeginning(String s){
    return s.matches("^[^\\d].*");
  }
  // returns true if the string contains a arbitrary number of characters
except b
  public boolean isIntersection(String s){
    return s.matches("([\\w&&[^b]])*");
  }
  // returns true if the string contains a number less then 300
  public boolean isLessThenThreeHundred(String s){
    return s.matches("[^0-9]*[12]?[0-9]{1,2}[^0-9]*");
  }

}
```

And a small JUnit Test to validates the examples.

```
package de.vogella.regex.string;

import org.junit.Before;
import org.junit.Test;

import static org.junit.Assert.assertFalse;
import static org.junit.Assert.assertTrue;

public class StringMatcherTest {
  private StringMatcher m;

  @Before
  public void setup(){
    m = new StringMatcher();
  }

  @Test
  public void testIsTrue() {
    assertTrue(m.isTrue("true"));
    assertFalse(m.isTrue("true2"));
    assertFalse(m.isTrue("True"));
  }

  @Test
  public void testIsTrueVersion2() {
    assertTrue(m.isTrueVersion2("true"));
    assertFalse(m.isTrueVersion2("true2"));
    assertTrue(m.isTrueVersion2("True"));;
  }

  @Test
  public void testIsTrueOrYes() {
    assertTrue(m.isTrueOrYes("true"));
    assertTrue(m.isTrueOrYes("yes"));
    assertTrue(m.isTrueOrYes("Yes"));
    assertFalse(m.isTrueOrYes("no"));
  }

  @Test
  public void testContainsTrue() {
    assertTrue(m.containsTrue("thetruewithin"));
  }

  @Test
  public void testIsThreeLetters() {
    assertTrue(m.isThreeLetters("abc"));
    assertFalse(m.isThreeLetters("abcd"));
  }

  @Test
  public void testisNoNumberAtBeginning() {
    assertTrue(m.isNoNumberAtBeginning("abc"));
    assertFalse(m.isNoNumberAtBeginning("1abcd"));
    assertTrue(m.isNoNumberAtBeginning("a1bcd"));
    assertTrue(m.isNoNumberAtBeginning("asdfdsf"));
  }

  @Test
  public void testisIntersection() {
    assertTrue(m.isIntersection("1"));
    assertFalse(m.isIntersection("abcksdfkdskfsdfdsf"));
    assertTrue(m.isIntersection("skdskfjsmcnxmvjwque484242"));
  }

  @Test
  public void testLessThenThreeHundred() {
    assertTrue(m.isLessThenThreeHundred("288"));
    assertFalse(m.isLessThenThreeHundred("3288"));
    assertFalse(m.isLessThenThreeHundred("328 8"));
    assertTrue(m.isLessThenThreeHundred("1"));
    assertTrue(m.isLessThenThreeHundred("99"));
    assertFalse(m.isLessThenThreeHundred("300"));
  }

}
```

5. Pattern and Matcher

For advanced regular expressions the `java.util.regex.Pattern` and `java.util.regex.Matcher` classes are used.

You first create a `Pattern` object which defines the regular expression. This `Pattern` object allows you to create a `Matcher` object for a given string. This `Matcher` object then allows you to do regex operations on a `String`.

```
package de.vogella.regex.test;

import java.util.regex.Matcher;
import java.util.regex.Pattern;

public class RegexTestPatternMatcher {
  public static final String EXAMPLE_TEST = "This is my small example string which I'm going to use for pattern matching.";

  public static void main(String[] args) {
    Pattern pattern = Pattern.compile("\\w+");
    // in case you would like to ignore case sensitivity,
    // you could use this statement:
    // Pattern pattern = Pattern.compile("\\s+", Pattern.CASE_INSENSITIVE);
    Matcher matcher = pattern.matcher(EXAMPLE_TEST);
    // check all occurance
    while (matcher.find()) {
      System.out.print("Start index: " + matcher.start());
      System.out.print(" End index: " + matcher.end() + " ");
      System.out.println(matcher.group());
    }
    // now create a new pattern and matcher to replace whitespace with tabs
    Pattern replace = Pattern.compile("\\s+");
    Matcher matcher2 = replace.matcher(EXAMPLE_TEST);
    System.out.println(matcher2.replaceAll("\t"));
  }
}
```

6. Java Regex Examples

The following lists typical examples for the usage of regular expressions. I hope you find similarities to your real-world problems.

6.1. Or

Task: Write a regular expression which matches a text line if this text line contains either the word "Joe" or the word "Jim" or both.

Create a project `de.vogella.regex.eitheror` and the following class.

```
package de.vogella.regex.eitheror;

import org.junit.Test;
import static org.junit.Assert.assertFalse;
import static org.junit.Assert.assertTrue;

public class EitherOrCheck {
  @Test
  public void testSimpleTrue() {
    String s = "humbapumpa jim";
    assertTrue(s.matches(".*(jim|joe).*"));
    s = "humbapumpa jom";
    assertFalse(s.matches(".*(jim|joe).*"));
    s = "humbaPumpa joe";
    assertTrue(s.matches(".*(jim|joe).*"));
    s = "humbapumpa joe jim";
    assertTrue(s.matches(".*(jim|joe).*"));
  }
}
```

6.2. Phone number

Task: Write a regular expression which matches any phone number.

A phone number in this example consists either out of 7 numbers in a row or out of 3 number, a (white)space or a dash and then 4 numbers.

```
package de.vogella.regex.phonenumber;

import org.junit.Test;

import static org.junit.Assert.assertFalse;
import static org.junit.Assert.assertTrue;


public class CheckPhone {

  @Test
  public void testSimpleTrue() {
    String pattern = "\\d\\d\\d([,\\s])?\\d\\d\\d\\d";
    String s= "1233323322";
    assertFalse(s.matches(pattern));
    s = "1233323";
    assertTrue(s.matches(pattern));
    s = "123 3323";
    assertTrue(s.matches(pattern));
  }
}
```

6.3. Check for a certain number range

The following example will check if a text contains a number with 3 digits.

Create the Java project `de.vogella.regex.numbermatch` and the following class.

```
package de.vogella.regex.numbermatch;
import java.util.regex.Matcher;
import java.util.regex.Pattern;

import org.junit.Test;

import static org.junit.Assert.assertFalse;
import static org.junit.Assert.assertTrue;
```

```
public class CheckNumber {


  @Test
  public void testSimpleTrue() {
    String s= "1233";
    assertTrue(test(s));
    s= "0";
    assertFalse(test(s));
    s = "29 Kasdkf 2300 Kdsdf";
    assertTrue(test(s));
    s = "99900234";
    assertTrue(test(s));
  }




  public static boolean test (String s){
    Pattern pattern = Pattern.compile("\\d{3}");
    Matcher matcher = pattern.matcher(s);
    if (matcher.find()){
      return true;
    }
    return false;
  }

}
```

6.4. Building a link checker

The following example allows you to extract all valid links from a webpage. It does not consider links which start with "javascript:" or "mailto:".

Create a Java project called *de.vogella.regex.weblinks* and the following class:

```
package de.vogella.regex.weblinks;

import java.io.BufferedReader;
import java.io.IOException;
import java.io.InputStreamReader;
import java.net.MalformedURLException;
import java.net.URL;
import java.util.ArrayList;
import java.util.List;
import java.util.regex.Matcher;
import java.util.regex.Pattern;

public class LinkGetter {
  private Pattern htmltag;
  private Pattern link;

  public LinkGetter() {
    htmltag = Pattern.compile("<a\\b[^>]*href=\"[^>]*>(.*?)</a>");
    link = Pattern.compile("href=\"[^>]*\">");
  }

  public List<String> getLinks(String url) {
    List<String> links = new ArrayList<String>();
    try {
      BufferedReader bufferedReader = new BufferedReader(new
InputStreamReader(new URL(url).openStream()));
      String s;
      StringBuilder builder = new StringBuilder();
      while ((s = bufferedReader.readLine()) != null) {
        builder.append(s);
      }

      Matcher tagmatch = htmltag.matcher(builder.toString());
      while (tagmatch.find()) {
        Matcher matcher = link.matcher(tagmatch.group());
        matcher.find();
        String link = matcher.group().replaceFirst("href=\"", "")
            .replaceFirst("\">", "")
            .replaceFirst("\"[\\s]?target=\"[a-zA-Z_0-9]*", "");
        if (valid(link)) {
          links.add(makeAbsolute(url, link));
        }
      }
    } catch (MalformedURLException e) {
      e.printStackTrace();
    } catch (IOException e) {
      e.printStackTrace();
    }
    return links;
  }

  private boolean valid(String s) {
    if (s.matches("javascript:.*|mailto:.*")) {
      return false;
    }
    return true;
  }

  private String makeAbsolute(String url, String link) {
    if (link.matches("http://.*")) {
      return link;
    }
    if (link.matches("/.*") && url.matches(".*$[^/]")) {
      return url + "/" + link;
    }
    if (link.matches("[^/].*") && url.matches(".*[^/]")) {
      return url + "/" + link;
    }
    if (link.matches("/.*") && url.matches(".*[/]")) {
      return url + link;
    }
    if (link.matches("/.*") && url.matches(".*[^/]")) {
      return url + link;
    }
    throw new RuntimeException("Cannot make the link absolute. Url: " + url
        + " Link " + link);
  }
}
```

6.5. Finding duplicated words

The following regular expression matches duplicated words.

```
\b(\w+)\s+\1\b
```

`\b` is a word boundary and `\1` references to the captured match of the first group, i.e., the first word.

The `(?!-in)\b(\w+) \1\b` finds duplicate words if they do not start with "-in".

Tip

Add `(?s)` to search across multiple lines.

6.6. Finding elements which start in a new line

The following regular expression allows you to find the "title" word, in case it starts in a new line, potentially with leading spaces.

```
(\n\s*)title
```

6.7. Finding (Non-Javadoc) statements

Sometimes (Non-Javadoc) are used in Java source code to indicate that the method overrides a super method. As of Java 1.6 this can be done via the `@Override` annotation and it is possible to remove these statements from your code. The following regular expression can be used to identify these statements.

```
(?s) /\* \(non-Javadoc\).*?\*/
```